

## Asbestos

"Asbestos" is a commercial term used to identify groups of silicate minerals of fibrous or asbestiform habit, which have the properties of high tensile strength, flexibility, chemical resistance, and heat resistance. These properties made these minerals useful in many manufactured products and industrial processes during the Twentieth Century. A few examples of the many uses of asbestos include brake and clutch linings, insulation, fireproof textiles, and filtration products. The use of asbestos in manufactured goods and processes in the United States has significantly decreased during the last 30 years because of health concerns related to asbestos exposure, especially among workers in those industries with constant exposure.

## Naturally Occurring Asbestos

"Naturally Occurring Asbestos" (NOA) is the term applied to the natural geologic occurrence of any of the types of asbestos. The presence of asbestos in nature is related to the chemistry of rocks in a particular area and the different geologic processes that have acted on those rocks through time. Formation of asbestos requires certain chemical conditions (available silica, magnesium, calcium, iron, sodium, and water) and physical conditions (appropriate temperature, pressure, and possibly stress). These conditions may be present in a variety of geologic settings but are more common in some settings than in others. Areas of faulting and shearing are areas moderately likely to contain NOA. Also, soils derived from asbestos-bearing rocks may contain free asbestos fibers.

Asbestos minerals most commonly occur in metamorphic rocks such as Serpentine. Metamorphic rocks are rocks that have "morphed" into another kind of rock. These rocks were once igneous or sedimentary rocks. How do sedimentary and igneous rocks change? The rocks are under tons and tons of pressure as plates of the earth move against each other during faulting, which fosters heat build up, and this causes them to change.



Serpentine is the California State Rock as it's found widely throughout the State. Serpentine rock is apple-green to black in color and its surfaces often have a shiny or wax-like appearance and a slightly soapy feel. The term "serpentine" is commonly used by the general public to refer to the rock type that geologists call "serpentinite." Serpentine occurs in central and northern California - in the Coast Ranges, the Klamath Mountains, and the Sierra Nevada foothills.

Serpentine is considered by geoscientists to be the metamorphosed remains of ultramafic igneous rocks, most commonly the rock peridotite, from the earth's mantle. The mantle is a thick layer of rock just below the earth's crust with rocks having very high magnesium and iron contents

and low amounts of silica. One theory for serpentine formation and occurrence currently in favor with many geoscientists is that peridotite underlying oceanic crustal rocks has been metamorphosed to serpentine in subduction zones that existed at various times in California's past. A subduction zone is an area where ocean crust rocks run into and slide underneath the edge of a continent. Because serpentine has a much lower density than peridotite, it rose toward the surface along major regional thrust faults associated with the subduction zones.



Serpentine rock is primarily composed of one or more of the three magnesium silicate minerals, "lizardite," "chrysotile," and "antigorite." Chrysotile often occurs as fibrous veinlets in serpentine. Chrysotile in fibrous form is the most common type of asbestos. Asbestos is a term applied to a group of silicate minerals that readily separates into thin, strong, and flexible fibers that are heat resistant. Lizardite and antigorite do not form asbestos fibers and instead are plate-like in form. Because serpentine often contains some asbestos, and exposure to asbestos fibers have potential human-health consequences, the California Air Resources Board and local air pollution

control districts have adopted regulations restricting the use and disturbance of this rock type.

**Sacramento and Placer Counties:** To help identify areas in the local region that may contain NOA, the California Department of Conservation, California Geological Survey (CGS), has prepared maps and reports for the Sacramento Metropolitan Air Quality Management District and Placer County Air Pollution Control District. These maps and reports can be found at:

[http://www.conservation.ca.gov/cgs/minerals/hazardous\\_minerals/asbestos/Pages/east\\_sacramento.aspx](http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/asbestos/Pages/east_sacramento.aspx) and [http://www.conservation.ca.gov/cgs/minerals/hazardous\\_minerals/asbestos/Pages/placer.aspx](http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/asbestos/Pages/placer.aspx).

NOA is known to be present in parts of eastern Sacramento County. The geology of eastern Sacramento County is characterized by a variety of igneous, metamorphic, and sedimentary rocks, some of which have been faulted or sheared. The geologic diversity in eastern Sacramento County provides some settings that are favorable for the presence of NOA.

Occurrences of chrysotile asbestos and amphibole asbestos have been reported from several locations in western Placer County. These are most commonly found in areas of ultramafic rocks and serpentinite and in areas of faulting and shearing. Economic geology reports indicate that chrysotile asbestos and amphibole asbestos were observed either within bodies of serpentinite or along their contacts with other types of rock. Commonly, the contacts are faulted or sheared.

**El Dorado County:** To help identify areas in the County that may contain NOA, a map and report were prepared for the El Dorado County Air Quality Management District by the CGS and can be found at:

[http://www.conservation.ca.gov/cgs/minerals/hazardous\\_minerals/asbestos/Pages/el\\_dorado.aspx](http://www.conservation.ca.gov/cgs/minerals/hazardous_minerals/asbestos/Pages/el_dorado.aspx) and a map at: <http://www.co.el-dorado.ca.us/emd/apcd/maps.htm>.

### **Reclamation Testing for Asbestos at Folsom Reservoir**

**Preconstruction Investigations:** Prior to the construction of Folsom Dam, Mormon Island Auxiliary Dam, and the eight dikes closing in the Folsom Reservoir rim, the U.S. Army Corps of Engineers conducted extensive field investigations of the materials in the area during the 1950s. Those studies concluded that ***no fibrous materials were noted*** in the amphibolite schist or in the granitic rocks, and the amphibolite schist consists of ***granular*** tremolite and amphibole hornblende minerals.

**Recent Investigations:** From 2003 to 2007, Reclamation conducted an extensive field investigation program along the shoreline of Folsom Reservoir. These explorations were conducted entirely on U.S. Government property around the reservoir rim between Brown's Marina, in El Dorado County (southeast side of the reservoir), and the east side of the State of California's Granite Bay Recreation Area, in Placer County (on the northeast side of the reservoir). In between these areas is a section of the Folsom Reservoir rim that is located in Sacramento County. The Reclamation field exploration program was conducted to geologically characterize the type and quantities of soil and rock materials present in the area. In addition, testing for the presence of NOA and other hazardous materials was conducted on the rock and soil encountered around the reservoir rim. The entire investigation program consisted of a total of 112 core drill holes and 205 test pits or trenches.

The rock and soil materials encountered during the investigations consisted principally of granitic rocks (quartz-diorite) or amphibolite schist. Minor amounts of Merhten Formation materials were found on ridge tops and recent alluvium in local drainages. The granitic rock underlies Dikes 1 through 7, the Right and Left Wing Dams, and the main concrete Folsom Dam. The granitic rock also underlies portions of the reservoir and makes up the reservoir rim beginning on the east side of Dike 7, on around to the north to include the entire Granite Bay Recreation Area. To the east of the granitic material, on the south side of the reservoir rim (to include under Dike 8, Mormon Island Auxiliary Dam, and the Brown's Marina area) is amphibolite schist of the Copper Hills Volcanic's Formation. Because of the presence of two different materials around the reservoir rim, Reclamation conducted separate investigations of each rock type, the North Shore (granitic materials) and the South Shore (amphibolite schist materials) investigations.

In summary, all materials encountered during the exploration program were inspected by Reclamation geologists using hand lenses and/or a binocular microscope. **No fibrous materials** were observed in any of the materials encountered.

Additionally, to comply with the State of California - Air Toxic Control Measure, the Sacramento Metropolitan Air Quality Management District regulations, and with Sacramento, Placer and El Dorado Air Quality Management District regulations, Reclamation submitted rock and soil samples collected during the investigation for laboratory analysis to determine the presence of asbestos. Independent laboratory analysis of samples collected were accomplished using a Polarized Light Microscope (PLM) and Scanning Electron Microscope (SEM) and found **no fibrous materials present** in the samples and reported no fibrous minerals were present.

To address community concerns, another sampling program was also conducted to specifically investigate and collect samples from the granitic materials encountered around the north shore of the reservoir in the area of Dikes 4 and 5 and along the Mooney Ridge shoreline near Dike 4. Splits of these samples were also submitted to an independent lab for analysis utilizing PLM analysis. They reported that **no fibrous minerals were present** in the granitic materials.

Materials along the northern shoreline of Folsom Reservoir primarily consist of alluvial and/or colluvial deposits overlying quartz diorite (granite) which has been deeply weathered. Alluvial deposits are sediments deposited by flowing water, as in a riverbed, flood plain, or delta, prior to construction of the reservoir that now make up the "beach sands" along the shoreline. Colluvial deposits are materials that move downslope by force of gravity and/or erosion and collect at the base of mountains or foothills, with little or no sorting.

Material within the Dike 5 Borrow Area and designated construction areas are identified as areas least likely to contain NOA by the Placer County Air Pollution Control District (APCD). The Placer County APCD states, "The review of geologic documents and fieldwork did not reveal the presence of NOA in any of these rock types in Placer County." Rock types referred to in this quotation includes the beach sand deposits and granitic rock encountered along the northern shoreline of Folsom Reservoir. The Placer County APCD further states, "The chemical and physical conditions that make other areas more likely to contain NOA are less likely to be present in these rocks." The Placer County APCD requires no asbestos testing for the areas designated for modifications to Dike 5.

In November 2007, five samples of beach sand were collected by Reclamation geologists from about 1.0 to 2.0 feet of depth within the Dike 5 Borrow Area for independent laboratory Transmission Electron Microscopy (TEM) testing and analysis. Samples were collected in accordance with procedures outlined in the California Air Resources Board report: Method 435. Each sample was analyzed at a magnification of up to 20,000X, where submicron-size particles can be observed. TEM test analysis measures the weight percentage of fibrous asbestos minerals within a given sample and provides a quantitative analysis of a given sample. TEM analysis is the definitive test method to quantify the weight percentage of NOA as stated in California Geologic Surveys report, Special Publication 124, Guidelines for Geologic Investigations of Naturally Occurring Asbestos, states that TEM is a definitive method to quantify percentages of asbestos. TEM analysis of all five samples submitted reported negative results for the presence of NOA. Weight percentages reported in TEM analysis found no asbestos in any of the five samples tested.

## **Conclusions**

Data collected by or reported to Reclamation provides conclusive evidence that NOA minerals are not present within the sampled native materials from the Dike 5 Borrow Area and are highly unlikely to be encountered under foreseeable circumstances. In the south shore areas of the project, testing to date has not positively identified and confirmed presence of NOA minerals, but due to the type of geology and rocks encountered, it cannot be proven conclusively that NOA minerals are not present. Although NOA is unlikely to be encountered in the south shore area, Reclamation will take precautionary measures in accordance with all required air quality permits and other requirements to reduce any potential for NOA to become airborne through the action of construction activities.